

Association of Anthropometric Indexes With Disease Severity in Male Patients With Chronic Obstructive Pulmonary Disease in Qazvin, Iran

American Journal of Men's Health
2018, Vol. 12(4) 1023–1028
© The Author(s) 2018
Reprints and permissions:
sagepub.com/journalsPermissions.nav
DOI: 10.1177/1557988318760053
journals.sagepub.com/home/jmh


Ramin Sami¹, Raheleh Sadegh², Neda Esmailzadeh³,
Sanaz Mortazian², Masoomeh Nazem², and Mohammadali Zohal²

Abstract

Malnutrition is one of the most important factors that lead to lower quality of life in patients suffering from chronic obstructive pulmonary disease (COPD). There are several methods for assessing malnutrition including anthropometric indexes. The aim of this study was to determine the association of anthropometric indexes with disease severity in male patients with COPD in Qazvin, Iran. This cross-sectional study was conducted on 72 male patients with COPD in Qazvin, Iran, from May to December 2014. Spirometry was performed for all participants. Disease severity was determined using the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guideline. Body mass index (BMI), mid-arm muscle circumference (MAMC), and triceps skinfold thickness (TSF) were measured. MAMC and TSF were categorized into three subgroups as <25th P, between 25th P and 75th P, and >75th P (Where P is the abbreviation for percentile.). Data were analyzed using ANOVA and logistic regression analysis. Mean age was 60.23 ± 11.39 years. Mean BMI was 23.23 ± 4.42 Kg/m², mean MAMC was 28.34 ± 3.72 cm², and mean TSF was 10.15 ± 6.03 mm. Mean BMI and MAMC in the GOLD stage IV were significantly lower than other stages. Of 72, 18.1% were underweight while 6.9% were obese. The GOLD stage IV was associated with 16 times increased risk of underweight and nine times increased risk of MAMC < 25th P. Disease severity was associated with BMI and MAMC as indexes of malnutrition in patients with COPD in the present study. The GOLD stage IV was associated with increased risk of underweight and low MAMC.

Keywords

Chronic obstructive pulmonary disease, malnutrition, body mass index, thinness, obesity

Received January 31, 2017; revised November 9, 2017; accepted November 14, 2017

Chronic obstructive pulmonary disease (COPD), as a systemic disease, has numerous extra-pulmonary adverse effects. It has been predicted that in 2020, COPD will reach the third cause of mortality and the fifth cause of disability worldwide (Pauwels & Rabe, 2004). COPD has both direct and indirect costs. Direct costs are related to the detection, medical care, prevention, and rehabilitation of the disease, while indirect costs are related to the morbidity and mortality of COPD (Guarascio, Ray, Finch, & Self, 2013). The disease not only costs governments due to pulmonary and extra-pulmonary effects but will also strongly affect quality of life in patients (Gvozdenović et al., 2007).

Malnutrition is one of the most important factors that lead to lower quality of life in patients suffering from COPD and could contribute to exacerbation of the disease

(Baccioglu, Gulbay, & Acıcan, 2014; Sanchez et al., 2011). In addition, malnutrition is also associated with increased mortality of the patients with COPD (Prescott et al., 2002;

¹Department of Internal Medicine, Isfahan University of Medical Sciences, Isfahan, Iran

²Metabolic Diseases Research Center, Qazvin University of Medical Sciences, Qazvin, Iran

³School of Health, Iran University of Medical Sciences, Tehran, Iran

Corresponding Author:

Mohammadali Zohal, MD, Associate Professor of Pulmonary Diseases, Metabolic Diseases Research Center, Qazvin University of Medical Sciences, Boo-ali Sina Hospital, Boo-ali Sina Street, Qazvin, 3413786165, Iran.

Email: zohal11@yahoo.com



Hallin et al., 2007). Hence, assessing malnutrition should be considered in management of COPD.

There are several methods for assessing malnutrition. Body weight and body mass index (BMI) are two of the simplest methods to assess nutritional status in patients suffering from COPD. The importance of BMI in these patients is well known as a criterion for the BODE index (Body mass index, airflow Obstruction, Dyspnea, Exercise capacity; de Torres et al., 2011). On the other hand, BMI is not specific enough. An obese patient can be malnourished (based on muscle mass loss due to inability to meet nutrient needs) but will not be identified by using BMI alone (Peltz, Aguirre, Sanderson, & Fadden, 2010; Frankenfield, Rowe, Cooney, Smith, & Becker, 2001). Therefore, other methods have been introduced and widely used for screening and assessment of malnutrition.

But what is important in malnourished patients with COPD is change in body composition in addition to change in body weight and weight loss is mostly due to the loss of muscle mass in most cases (Soler, Sánchez, Román, Martínez, & Perpiñá, 2004). This situation is different from what happens during starvation in which reduction of adipose tissue occurs. The loss of fat free mass occurs without weight loss and BMI remains stable while the patient has malnutrition. Studies have reported that reduction in fat free mass is more associated with mortality rather than weight loss or reduction in any part of the body (Soler et al., 2004; Karakas, Bilgin, Polatli, Ozlem, & Tas-Gulen, 2014).

Measuring anthropometric indexes has been accepted as a simple and inexpensive method for assessing body composition. Measurement of skinfold thickness at particular body sites including triceps skinfold thickness (TSF) assesses body fat mass (Peltz et al., 2010). On the other hand, muscle mass can be estimated using indirect methods such as mid-arm muscle circumference (MAMC). Therefore, the aim of this study was to determine the association of anthropometric indexes including BMI, MAMC, and TSF with disease severity in male patients with COPD in Qazvin, Iran.

Methods

This cross-sectional study was conducted on 72 male patients suffering from COPD in Qazvin, Iran from May to December 2014. The study was confirmed by the ethics committee of Qazvin University of Medical Sciences. All participants submitted written informed consent forms.

The patients referred to the lung diseases clinic in Qazvin were entered in the study. At the time of study, all the patients were in stable condition and at least 1 month was passed since the last acute phase of their disease. In

addition, the patients were not diagnosed with any other chronic disease such as liver disease, kidney disease, cancer, or any disease-inducing cachexia.

Spirometry was performed for all participants and forced expiratory volume in 1 s (FEV1), forced vital capacity (FVC), and FEV1/FVC ratio were measured. Disease severity was determined using the Global Initiative for Chronic Obstructive Lung Disease (GOLD) guideline (Vestbo et al., 2013), and patients were classified in four groups as follows: GOLD I (mild): $FEV1 \geq 80\%$; GOLD II (moderate): $50\% \leq FEV1 < 80\%$; GOLD III (severe): $30\% \leq FEV1 < 50\%$; GOLD IV (very severe): $FEV1 < 30\%$.

Anthropometric indexes included weight, height, BMI, MAMC, and TSF. All anthropometric indexes were measured by a single trained general practitioner. The body weight was measured using a Seca scale with 0.1 kg accuracy in light clothes and no shoes. Height was measured using a standard stadiometer with the participant wearing no shoes and was recorded to the nearest centimeter to an accuracy of ± 0.1 cm. BMI was calculated as weight (kg) per height squared (m^2). Based on the Centers for Disease Control and Prevention (CDC) classification, the patients were divided into four groups: underweight ($BMI < 18.5$), normal weight ($18.5 \leq BMI \leq 24.9$), overweight ($25 \leq BMI \leq 29.9$), and obese ($30 \leq BMI$).

MAMC was measured using a nonstretchable plastic measure tape to an accuracy of ± 0.1 cm. The distance between olecranon and acromion was measured and then midway was identified as MAMC. MAMC was categorized into three subgroups based on the reference table number in terms of percentile and related age and gender (as $MAMC < 25^{th} P$, $25^{th} P < MAMC < 75^{th} P$, and $MAMC > 75^{th} P$; Fryar, Gu, & Ogden, 2012). TSF was measured at the triceps muscle site using a calliper (VOGEL, Germany) and was categorized into three subgroups based on the reference table number in terms of percentile and related age and gender (as $TSF < 25^{th} P$, $25^{th} P < TSF < 75^{th} P$, and $TSF > 75^{th} P$; Fryar, et al., 2012).

The normality of variables of interest was examined using Kolmogorov Smirnov test and all variables had normal distribution. Data were presented as mean \pm SD or percentage where appropriate. Categorical variables were analyzed using χ^2 test. Anthropometric values were compared between GOLD stages using analysis of variance (ANOVA). Tukey test was used as a post hoc test. The relationship between anthropometric indices and FEV1 was assessed by Pearson's correlation coefficients. The independent associations of disease severity as ordinal predictor variable and anthropometric indexes ($BMI < 18.5$, $MAMC < 25^{th} P$, and $TSF < 25^{th} P$) were assessed by logistic regression analysis. The odds ratio (OR) and 95% confidence intervals (CI) were expressed. *p* values less than .05 were considered as statistically significant.

Table 1. Characteristics of Study Subjects by Disease Severity.

	Disease severity by GOLD				p value
	I (n = 11)	II (n = 29)	III (n = 22)	IV (n = 10)	
Age	59.00 ± 11.89	61.51 ± 11.87	60.63 ± 12.10	57.00 ± 8.27	.731
BMI (kg/m²)	24.61 ± 2.95	23.93 ± 4.13	23.63 ± 4.71	18.84 ± 3.76	.006 ^a
MAMC (cm²)	28.68 ± 3.29	29.46 ± 3.02	28.52 ± 3.72	24.30 ± 3.78	.001 ^a
TSF (mm)	10.54 ± 3.72	10.89 ± 7.47	10.23 ± 5.60	7.40 ± 3.80	.470

Note. Data are presented as mean ± SD. ^aDifference was related to GOLD IV stage and other GOLD stages. GOLD = Global Initiative for Chronic Obstructive Lung Disease; BMI = body mass index; MAMC = mid-arm muscle circumference; TSF = triceps skinfold thickness.

Table 2. Association of Anthropometric Indexes Categories and Disease Severity.

Variables	Total	Disease severity by GOLD				p value
		I (n = 11)	II (n = 29)	III (n = 22)	IV (n = 10)	
BMI						.002
Underweight	18.10	9.10	6.90	18.20	60.00	
Normal weight	43.10	18.20	58.60	40.90	30.00	
Overweight	31.90	72.70	24.10	31.80	10.00	
Obese	6.90	0	10.30	9.10	0	
MAMC						.054
<25 th P	23.90	18.20	17.20	18.20	66.70	
25 th P–75 th P	21.10	18.20	17.20	27.30	22.20	
>75 th P	54.90	63.60	65.50	54.50	11.10	
TSF						.330
<25 th P	43.70	27.30	44.80	40.90	66.70	
25 th P–75 th P	32.40	54.50	27.60	27.30	33.30	
>75 th P	23.90	18.20	27.60	31.80	0	

Note. Data are presented in percentage. GOLD = Global Initiative for Chronic Obstructive Lung Disease; BMI = body mass index; MAMC = mid-arm muscle circumference; TSF = triceps skinfold thickness.

Results

Seventy two male patients were entered in the study. Mean age was 60.23±11.39 years. Mean BMI was 23.23 ± 4.42 kg/m², mean MAMC was 28.34 ± 3.72 cm², and mean TSF was 10.15 ± 6.03 mm. Of 72, 15.3%, 40.3%, 30.6%, and 13.9% of the patients were at the GOLD stage I, II, III, and IV of the disease, respectively.

Anthropometric characteristics of the study subjects by disease severity are reported in Table 1. Mean BMI and MAMC were significantly lower in GOLD stage IV compared to the other stages. BMI ($r = .275$, $p = .020$) and MAMC ($r = .237$, $p = .045$) had positive significant correlation with FEV1 but there was no correlation between TSF and FEV1 ($r = .119$, $p = .320$).

Of all patients, 18.1% were underweight while 6.9% were obese. Associations of anthropometric indexes categories and disease severity are reported in Table 2. In univariate analysis, underweight was significantly associated with disease severity. An association with borderline significance

was identified between MAMC < 25th P and disease severity. In logistic regression analysis, the GOLD stage IV was associated with 16 times increased risk of underweight and nine times increased risk of MAMC < 25th P (Table 3).

Discussion

The prevalence of underweight was 18% in patients suffering from COPD based on BMI in the present study. These results are in accordance with previous studies (de Torres et al., 2011; Soler-Cataluña et al., 2005). The high prevalence of underweight can be attributed to the unbalanced energy state between energy intake and expenditure due to respiratory effort in patients with COPD (Hallin et al., 2007; Debigaré et al., 2003; Planas et al., 2005).

Weight loss is not the only predictor of malnutrition. Changes in body composition, for example, muscle mass reduction, are more associated with lifestyle and mortality in patients suffering from COPD (Shoup et al., 1997;

Table 3. Logistic Regression Analysis of Anthropometric Indexes and Disease Severity.

		OR ^a	95% CI	p value
BMI < 18.5				
Disease severity by GOLD	I	Reference	–	–
	II	0.69	[0.05, 8.62]	.775
	III	2.14	[0.21, 22.08]	.523
	IV	16.29	[1.42, 186.92]	.025
MAMC < 25th P				
Disease severity by GOLD	I	Reference	–	–
	II	0.92	[0.15, 5.64]	.925
	III	0.98	[0.15, 6.46]	.988
	IV	9.25	[1.16, 73.76]	.036
TSF < 25th P				
Disease severity by GOLD	I	Reference	–	–
	II	2.13	[0.47, 9.72]	.330
	III	1.82	[0.38, 8.84]	.455
	IV	4.46	[0.79, 37.42]	.084

Note. ^aAdjusted for age. OR = odds ratio; GOLD = Global Initiative for Chronic Obstructive Lung Disease; BMI = body mass index; MAMC = mid-arm muscle circumference; TSF = triceps skinfold thickness.

Ischaki et al., 2007). Therefore, evaluation of muscle mass reduction as well as other indicators of body composition should be considered in assessment of malnutrition in patients with COPD.

However, the methods of evaluating muscle mass reduction and body composition such as dual-energy X-ray absorptiometry, electrical impedance analysis, and impedance spectroscopy are extremely expensive; several studies have been designed on the basis of inexpensive methods. Anthropometric assessment has also been used as an inexpensive alternative for evaluation of body composition (Steiner, Barton, Singh & Morgan, 2002; Miller et al., 2009; Lerario, Sachs, Lazaretti-Castro, Saraiva, & Jardim, 2006).

In the present study, anthropometric assessment of patients with COPD was focused on BMI, MAMC, and TSF. There was a significant correlation between BMI and FEV1 in the present study, and disease severity was associated with underweight in univariate analysis. In a study on 63 patients with stable COPD in Tehran, Iran, there was also a significant correlation between BMI ($r = .2, p = .020$) and FEV1. Moreover, BMI was reduced as severity of the disease was increased (Yazdanpanah, Shidfar, Javad Mousavi, Heidarnajad, & Haghani, 2011). Steuten et al. (2006) in a study on 317 patients with COPD in Netherland reported that the prevalence of low body weight in GOLD stage IV was strongly higher than other stages. It should be noted that dyspnea in underweight patients is more prevalent than normal weight patients since respiratory muscle strength decreases in underweight patients (Steuten et al., 2006).

In logistic regression analysis, the GOLD stage IV was associated with 16 times increased risk of underweight in

the present study. Eriksson et al. (2016) in a study on 3,942 subjects reported that only severe COPD was associated with three times increased risk of underweight. BMI is a very quick and easy to complete method that does not require special training or equipment in comparison to what is needed for other methods.

There was a significant correlation between MAMC and FEV1 in the present study, and disease severity was associated with low MAMC. In Yazdanpanah et al.'s (2011) study, MAMC had positive significant correlation with FEV1 ($r = .2, p = .030$) and depletion of muscle mass was significantly increased as the disease progressed. The GOLD stage IV was associated with nine times increased risk of low MAMC in the present study. MAMC is an indicator of muscle mass and has an important role in COPD; its association with mortality in patients suffering from COPD is stronger than BMI (Soler-Cataluña et al., 2005; Ho et al., 2016; Marquis et al., 2016).

Another anthropometric index which is used in the evaluation of fat mass is skinfold anthropometry. Skinfold anthropometry has been demonstrated as an accurate, available, and inexpensive method for determination of fat mass and fat free mass (Hronek et al., 2013). While skinfold anthropometry can provide a measure of body composition, it can be erroneous particularly if training has not been provided. TSF is part of skinfold anthropometry and an indicator of subcutaneous fat stores and total body fat mass. After calculating fat mass, lean body mass is calculable by subtracting fat mass from body mass. In this study, there was no association between TSF and disease severity that is similar to the previous studies (Baccioglu et al., 2014; Soler et al., 2004). The lack of

association between these indexes and disease severity may be due to the fact that TSF is highly affected by subcutaneous edema, so it may be reported higher than the real value.

There are many highly cited publications that have reported fat free mass index (FFMI) is associated with COPD prognosis (Schols, Broekhuizen, Welings-Scheepers, & Wouters, 2005; Vestbo et al., 2006). FFMI based on bioelectric impedance or dual-energy X-ray absorptiometry methods has been associated with disease severity and prognosis in patients with COPD (Miller et al., 2009; Thibault, Le Gallic, Picard-Kossovsky, Darmaun, & Chambellan, 2010). But, these methods are expensive and are not applicable in clinics. Therefore, using simple methods such as anthropometric indexes and skinfold anthropometry has been suggested for clinical practice.

The present study had some limitations including the cross-sectional design and the number of patients analyzed with COPD. Using BMI to assess body composition and only one site to examine fat free mass and fat mass are also limitations of this study.

In conclusion, disease severity was associated with BMI and MAMC as indexes of malnutrition in patients with COPD in the present study. The GOLD stage IV was associated with increased risk of underweight and low MAMC. BMI and MAMC can be used for malnutrition screening in patients suffering from COPD. Measurement of additional skinfold sites as well as waist circumference or measures of visceral adiposity may provide a better indicator of body composition. Further longitudinal studies are required to evaluate the association of anthropometric indexes with disease severity in patients with COPD.

Acknowledgments

The authors would like to thank the participants involved in this study and the staff of the Metabolic Diseases Research Center and the staff of the Center for Clinical Research at Qazvin Children Hospital, affiliated to Qazvin University of Medical Sciences.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

- Baccioglu, A., Gulbay, B. E., & Acıcan, T. (2014). Body composition in patients with stable chronic obstructive pulmonary disease: Comparison with malnutrition in healthy smokers. *Eurasian Journal of Medicine*, *46*(3), 169–175.
- Debigaré, R., Marquis, K., Côté, C. H., Tremblay, R. R., Michaud, A., LeBlanc, P., & Maltais, F. (2003). Catabolic/anabolic balance and muscle wasting in patients with COPD. *Chest*, *124*(1), 83–89.
- de Torres, J. P., Casanova, C., Marín, J. M., Pinto-Plata, V., Divo, M., Zulueta, J. J., ... Celli, B. R. (2014). Prognostic evaluation of COPD patients: GOLD 2011 versus BODE and the COPD comorbidity index COTE. *Thorax*, *69*(9), 799–804.
- Eriksson, B., Backman, H., Bossios, A., Bjerg, A., Hedman, L., Lindberg, A., ... Lundbäck, B. (2016). Only severe COPD is associated with being underweight: Results from a population survey. *ERJ Open Research*, *2*(3). pii: 00051-2015.
- Frankenfield, D. C., Rowe, W. A., Cooney, R. N., Smith, J. S., & Becker, D. (2001). Limits of body mass index to detect obesity and predict body composition. *Nutrition*, *17*(1), 26–30.
- Fryar, C. D., Gu, Q., & Ogden, C. L. (2012). Anthropometric reference data for children and adults: United States, 2007–2010. *Vital and Health Statistics*, *11*(252), 1–48.
- Guarascio, A. J., Ray, S. M., Finch, C. K., & Self, T. H. (2013). The clinical and economic burden of chronic obstructive pulmonary disease in the USA. *ClinicoEconomics & Outcomes Research*, *5*, 235–245.
- Gvozdenović, B. S., Mitić, S., Zugić, V. G., Gvozdenović, A. T., Lazović, N. M., & Plavšić, S. (2007). Relationship between degree of dyspnoea and health-related quality of life in patients with chronic obstructive pulmonary disease. *Srpski Arhiv Za Celokupno Lekarstvo*, *135*(9–10), 547–553.
- Hallin, R., Gudmundsson, G., Ulrik, C. S., Nieminen, M. M., Gislason, T., Lindberg, E., ... Janson, C. (2007). Nutritional status and long-term mortality in hospitalised patients with chronic obstructive pulmonary disease (COPD). *Respiratory Medicine*, *101*(9), 1954–1960.
- Ho, S. C., Wang, J. Y., Kuo, H. P., Huang, C. D., Lee, K. Y., Chuang, H. C., ... Hsu, M. F. (2016). Mid-arm and calf circumferences are stronger mortality predictors than body mass index for patients with chronic obstructive pulmonary disease. *International Journal of Chronic Obstructive Pulmonary Disease*, *11*, 2075–2080.
- Hronek, M., Kovarik, M., Aimova, P., Koblizek, V., Pavlikova, L., Salajka, F., & Zadak, Z. (2013). Skinfold anthropometry-the accurate method for fat free mass measurement in COPD. *COPD: Journal of Chronic Obstructive Pulmonary Disease*, *10*(5), 597–603.
- Ischaki, E., Papatheodorou, G., Gaki, E., Papa, I., Koulouris, N., & Loukides, S. (2007). Body mass and fat-free mass indices in COPD: Relation with variables expressing disease severity. *Chest*, *132*(1), 164–169.
- Karakas, S., Bilgin, M. D., Polatli, M., Ozlem, S., & Tasgulen, S. (2014). Anthropometric methods in evaluation of chronic obstructive pulmonary disease. *Collegium Antropologicum*, *38*(2), 499–504.
- Lerario, M. C., Sachs, A., Lazaretti-Castro, M., Saraiva, L. G., & Jardim, J. R. (2006). Body composition in patients with chronic obstructive pulmonary disease: Which method to use in clinical practice? *British Journal of Nutrition*, *96*(1), 86–92.

- Marquis, K., Debigaré, R., Lacasse, Y., LeBlanc, P., Jobin, J., Carrier, G., & Maltais, F. (2002). Midthigh muscle cross-sectional area is a better predictor of mortality than body mass index in patients with chronic obstructive pulmonary disease. *American Journal of Respiratory and Critical Care Medicine*, 166(6), 809–813.
- Miller, A., Strauss, B. J., Mol, S., Kyoong, A., Holmes, P. H., Finlay, P., ... Guy, P. (2009). Dual-energy X-ray absorptiometry is the method of choice to assess body composition in COPD. *Respirology*, 14(3), 411–418.
- Pauwels, R. A., & Rabe, K. F. (2004). Burden and clinical features of chronic obstructive pulmonary disease (COPD). *Lancet*, 364(9434), 613–620.
- Peltz, G., Aguirre, M. T., Sanderson, M., & Fadden, M. K. (2010). The role of fat mass index in determining obesity. *American Journal of Human Biology*, 22(5), 639–647.
- Planas, M., Alvarez, J., García-Peris, P. A., de la Cuerda, C., de Lucas, P., Castellà, M., ... Reyes, L. (2005). Nutritional support and quality of life in stable chronic obstructive pulmonary disease (COPD) patients. *Clinical Nutrition*, 24(3), 433–441.
- Prescott, E., Almdal, T., Mikkelsen, K. L., Tofteng, C. L., Vestbo, J., & Lange, P. (2002). Prognostic value of weight change in chronic obstructive pulmonary disease: Results from the Copenhagen City Heart Study. *European Respiratory Journal*, 20(3), 539–544.
- Sanchez, F. F., Faganello, M. M., Tanni, S. E., Lucheta, P. A., Pelegrino, N. G., Hasegawa, S. H., ... Godoy, I. (2011). Anthropometric midarm measurements can detect systemic fat-free mass depletion in patients with chronic obstructive pulmonary disease. *Brazilian Journal of Medical and Biological Research*, 44(5), 453–459.
- Schols, A. M., Broekhuizen, R., Weling-Scheepers, C. A., & Wouters, E. F. (2005). Body composition and mortality in chronic obstructive pulmonary disease. *American Journal of Clinical Nutrition*, 82(1), 53–59.
- Shoup, R., Dalsky, G., Warner, S., Davies, M., Connors, M., Khan, M., ... ZuWallack, R. (1997). Body composition and health-related quality of life in patients with obstructive airways disease. *European Respiratory Journal*, 10(7), 1576–1580.
- Soler, J. J., Sánchez, L., Román, P., Martínez, M. A., & Perpiñá, M. (2004). Prevalence of malnutrition in outpatients with stable chronic obstructive pulmonary disease. *Archivos de Bronconeumología*, 40(6), 250–258.
- Soler-Cataluña, J. J., Sánchez-Sánchez, L., Martínez-García, M. A., Sánchez, P. R., Salcedo, E., & Navarro, M. (2005). Mid-arm muscle area is a better predictor of mortality than body mass index in COPD. *Chest*, 128(4), 2108–2115.
- Steiner, M. C., Barton, R. L., Singh, S. J., & Morgan, M. D. (2002). Bedside methods versus dual energy X-ray absorptiometry for body composition measurement in COPD. *European Respiratory Journal*, 19(4), 626–631.
- Steuken, L. M., Creutzberg, E. C., Vrijhoef, H. J., & Wouters, E. F. (2006). COPD as a multicomponent disease: Inventory of dyspnoea, underweight, obesity and fat free mass depletion in primary care. *Primary Care Respiratory Journal*, 15(2), 84–91.
- Thibault, R., Le Gallic, E., Picard-Kossovsky, M., Darmaun, D., & Chambellan, A. (2010). Assessment of nutritional status and body composition in patients with COPD: Comparison of several methods. *La Revue des Maladies Respiratoires*, 27(7), 693–702.
- Vestbo, J., Hurd, S. S., Agustí, A. G., Jones, P. W., Vogelmeier, C., Anzueto, A., ... Rodriguez-Roisin, R. (2013). Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease: GOLD executive summary. *American Journal of Respiratory and Critical Care Medicine*, 187(4), 347–365.
- Vestbo, J., Prescott, E., Almdal, T., Dahl, M., Nordestgaard, B. G., Andersen, T., ... Lange, P. (2006). Body mass, fat-free body mass, and prognosis in patients with chronic obstructive pulmonary disease from a random population sample: Findings from the Copenhagen City Heart Study. *American Journal of Respiratory and Critical Care Medicine*, 173(1), 79–83.
- Yazdanpanah, L., Shidfar, F., Javad Mousavi, S.A., Heidarnajad, H., & Haghani, H. (2011). Anthropometric indices, fat-free mass index and their relationship with pulmonary function in COPD patients. *Razi Journal of Medical Sciences*, 18(85), 42–51. (In Persian)